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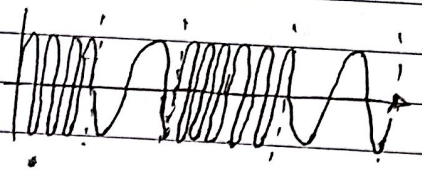

FSK is just equal to two ON off keying

FSK = 2 BASK

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Test

Q1) A TV signal with Bandwidth of 4.5 MHz it is Sampled using ~~fast~~ sampling rate 20% haigher than the nyquist (sample princible rate) and the samples are Quantized to 1024 levels it the signal is transmitted using ASK find minimum bandwidth to carry the signal.

$R_s > 2 B$

$R_s > 2 \times 4.5 \geq 9$ MHz

$L = 1024 \quad n = 10$

$\frac{90 \times 20}{100} = 10.8$ * no. of bit

$R_b = 108$

$2R_b = 216$ MHz

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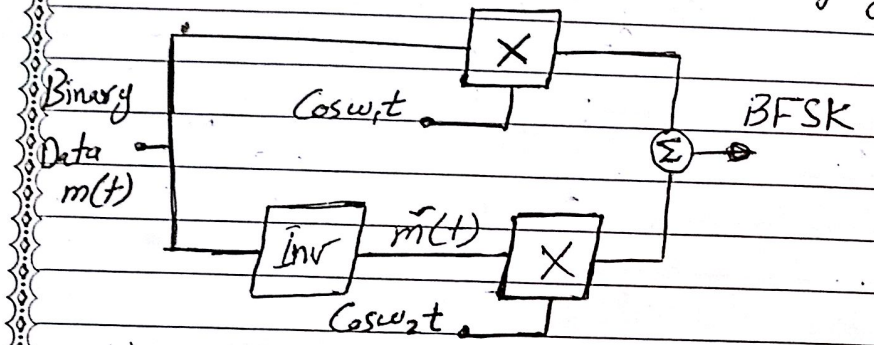
Digital Communication

Binary Frequency shift keying

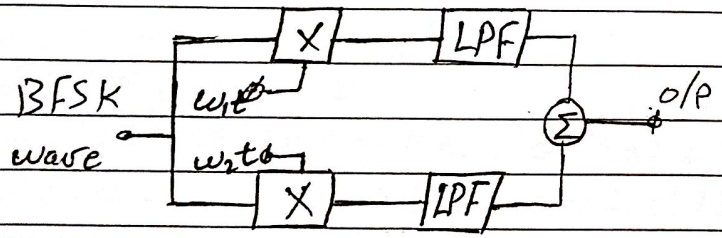


m(t) 0 or 1

m(t) = 1 Cosw1t

m(t) = 0 Cosw2t

Coherent Detector



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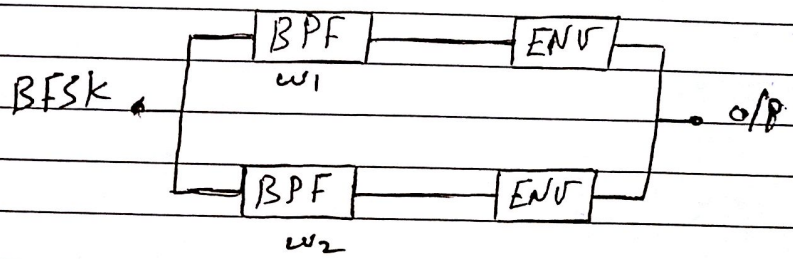
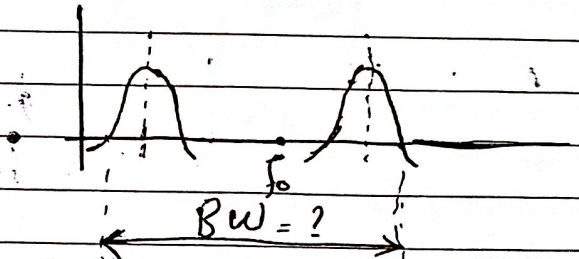
Envelop Detector



FSK spectrum



$BW = 2R_b + 2\Delta f$

$\omega = \omega_0 \pm \Delta\omega$

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$\Delta f = 75$ $f_{s2} = 15$

اوجد ال BW \leftarrow $BW =$

if the carrier of an FSK transmitter 90MHz

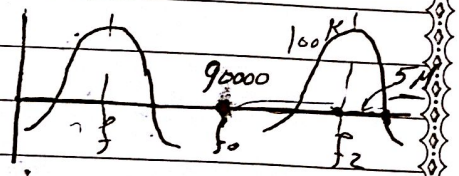
$R_b = 5$ Mb.ps

The maximmum diviation 100 kHz = Δf

Find the following :-

1- The maximum frequency at the output

$\Delta f = 100$ kHz



95.1 MHz

2- The Bandwidth

$BW = 2R_b + 2\Delta f = 5*2 + 2*100K$

$= 10.2$ MHz

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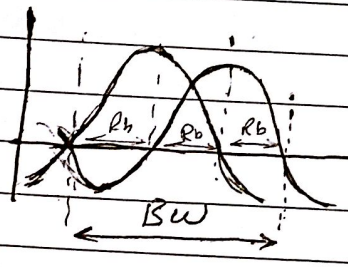
ORTHOGONAL BFSK

$R_b = f_2 - f_1$



$BW = 3R_b$

4 ary FSK

4FSK

means we have four frequency. digital may have more than two levels.

f_1, f_2, f_3, f_4

we need 4 levels.

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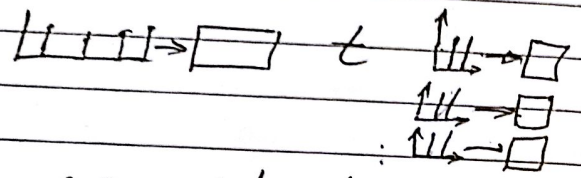
This happen by taking two bits at the same time to represent a level. and this can be done by using a serial to parallel Converter

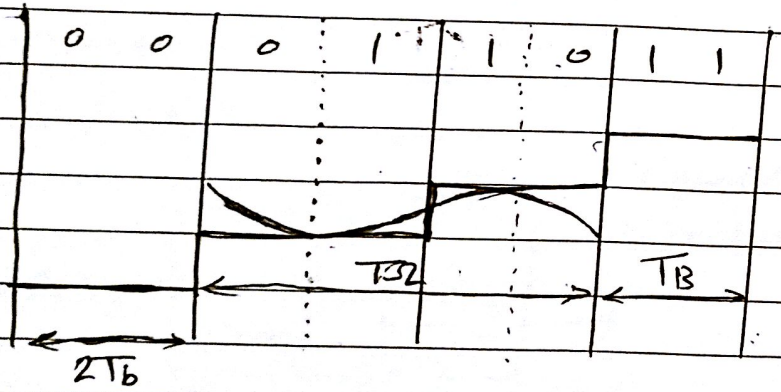


0 0 ↑ level

0 1 ↑ level

1 0 ↑ level

1 1 ↑ level



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T_b ⇒ bit time

T_B ⇒ Simple Period. or Baud period

The rate called Baud rate or Simple rate, modulation rate.

$$R_B = \frac{1}{T_B} = \frac{R_b}{2}$$

$$T_B = 2T_b$$

$$R_b = 2R_B$$

$$T_2 = 4T_b \quad \therefore T_2 = 2T_B$$

$$f_2 = \frac{R_b}{4} = \frac{R_B}{2}$$

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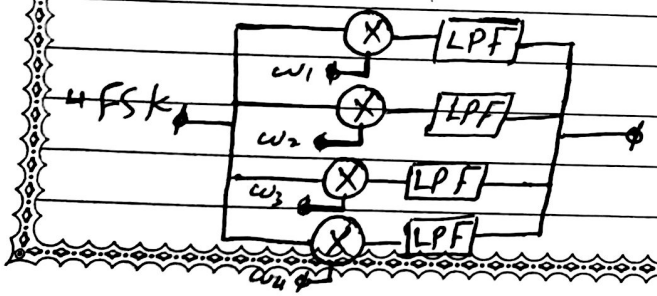
Digital Communications

Q) Describe the structure and operation of a 4FSK modulator and detector, with diagrams. Show the spectrum diagram and find the Bandwidth if the input data all rate

$R_b = 9$ Mbps

The VCO

Detector:



$\cos\omega_1 t \cdot \cos\omega_2 t = \frac{1+\cos 2\omega t}{2}$

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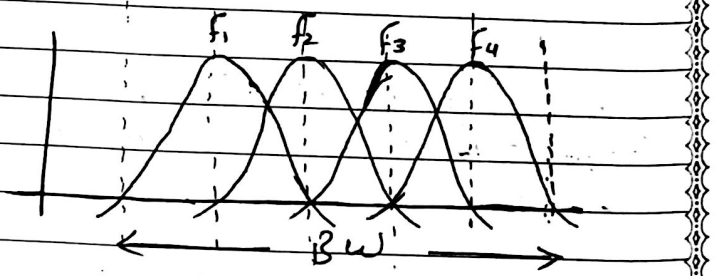
$\cos\omega_1 t \cdot \cos\omega_2 t = \frac{1}{2}\left(\cos(\omega_1+\omega_2)t + \cos(\omega_1-\omega_2)t\right)$



Bandwidth ⇒ تتناسب بالـ Baderate
وبالـ Bitrate تتناسب بالـ

by Binary = $3R_b$

$BW = 5\frac{R_b}{2}$

if the Lowest frequency = 95 MHz
& R_b = 10 Mbps

Find the highest Frequency to be reached after modulation.

$BW = \frac{5R_b}{2} = \frac{5*10}{2} = 25$ MHz

highest frequency = 95 + 25 = 115 MHz

Carrier = 107.5 MHz

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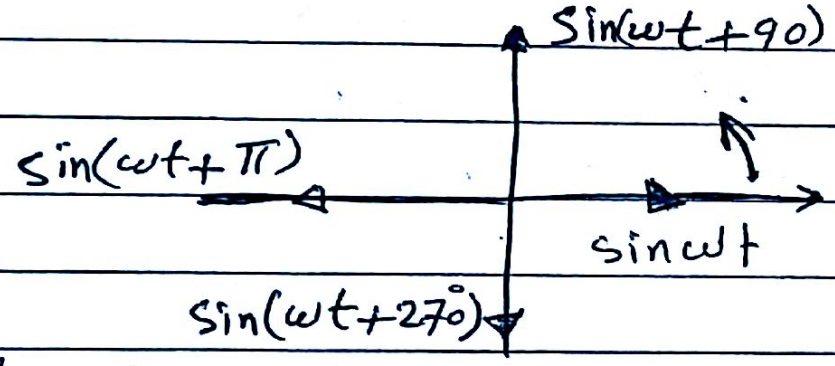
Digital phase Modulation

The phase of the Carrier will varying ~~with~~ accordance with the digital signal.

Let us discripe the phase with a vector diagram (phase diagram)

- The phase range from ~~0~~ 0 to 360 degree



the phase vector start from the X axis the counter clock wise

let this X axis represent the Carrier frequency.

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Digital phase Modulation

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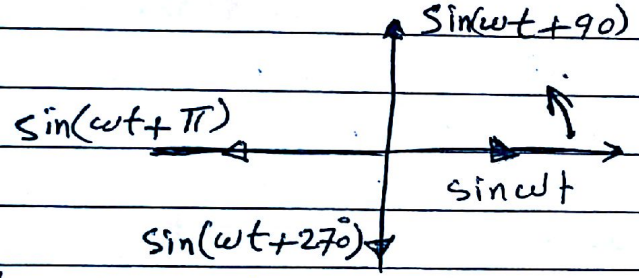

the phase vector start from the X axis the Counter clocke wise

Let Axis X axis represent the Carrier frequency.

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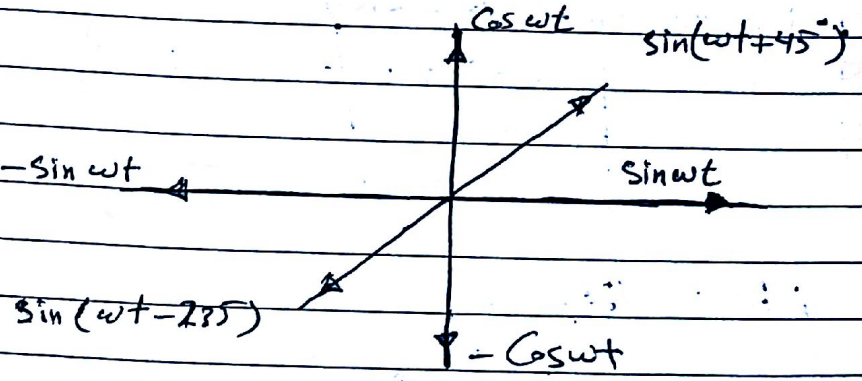
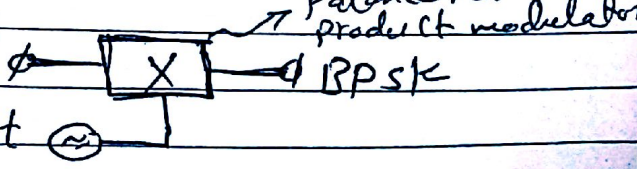
the phase (sin wt) change depending on the digital signal.

(0, 1) have two phase and have only two vector.



Binary phase shift key

1- Block diagram :-



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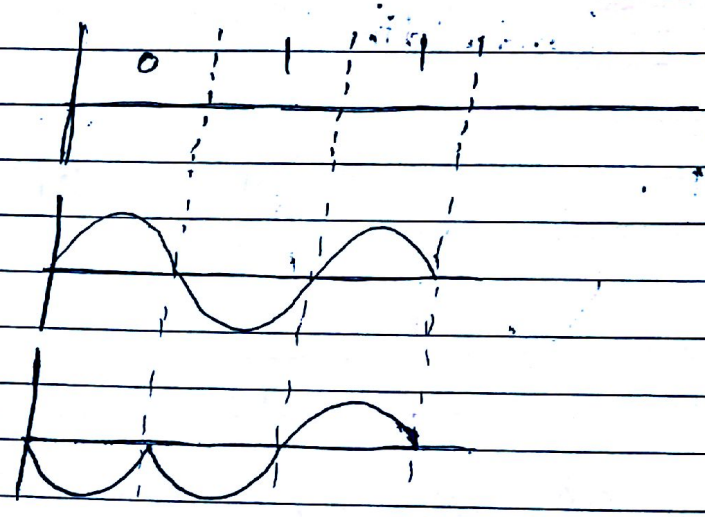

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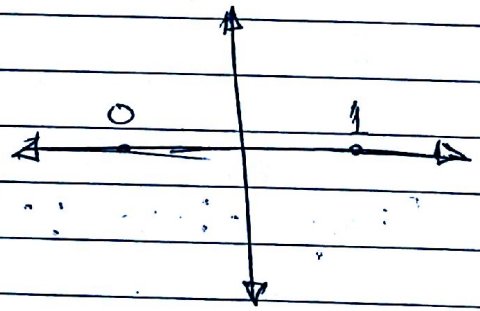
0 ⟶ -1 ⇒ أعكس

1 ⟶ 1 ⇒ اترکها کما هي

Truth table :-

Input	BPSK
0	$-\sin \omega t = \sin(\omega t + \pi)$
1	$\sin \omega t$

Phase diagram :



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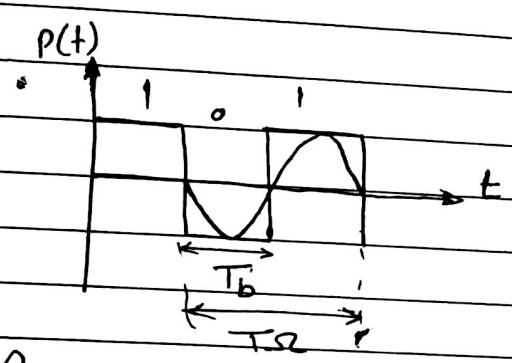
Bandwidth



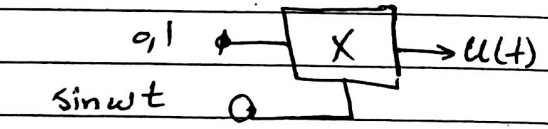
$$R_b = \frac{1}{T_b} = \frac{1}{T_B} = R_B$$

$$f_{\Omega} = \frac{R_b}{2} = \frac{R_B}{2}$$

~~the bit rate~~

$$T_{\Omega} = \frac{1}{f_{\Omega}} = 2T_b$$

$$f_{\Omega} = \frac{R_b}{2} = \frac{R_B}{2}$$



$$u(t) = \sin 2\pi f t - \sin 2\pi f_{\Omega} t$$

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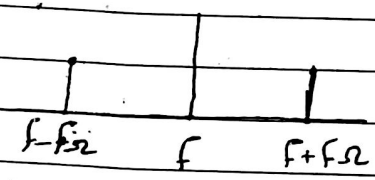
$$u(t) = \frac{\cos 2\pi (f - f_{\Omega})t}{2} - \frac{\cos 2\pi (f + f_{\Omega})t}{2}$$

Spectrum BPSK



$$BW = 2f_{\Omega} = R_b = R_B$$

always the BW is optain from the Boderate

BW <= أكبر من عدد البتات

* Quadrature phase Shift * Keying

QPSK 4PSK

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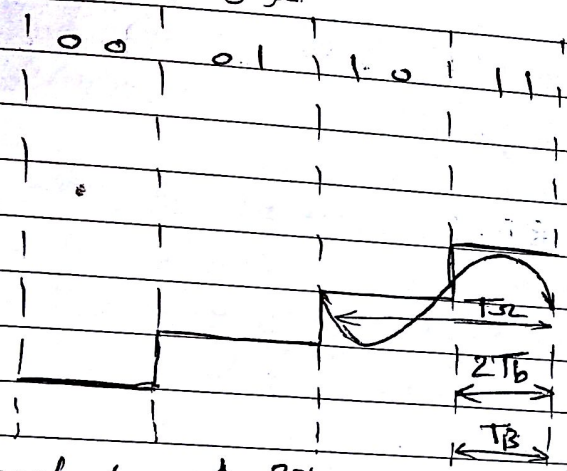

each two Bits Correspond to a level.

each level will give a phase

$T_B = 2T_b$ / $T_{S2} = 4T_b$

$\therefore f_{S2} = \frac{R_b}{4} = \frac{R_B}{2}$

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QPSK:

1- Block diagram
2- Truth table
3- phase diagram
4- Detector
5- Spectrum & BW
6- Examples.

Subject as question:-

- Draw a Block Diagram of QPSK Modulator and explain from it the truth table & phase digram.
- explain the structure and operation of a QPSK detector.
- A digital signal with eight (8Mbps) mega bit per second is transmitted using QPSK modulator.

if the data signal in phase channel

$I = 1$

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and Quad phase channel Q = 0

determine the following:

when the carrier is sinωt

1- Amplitude of the modulated wave.

2- The new phase of the modulated wave.

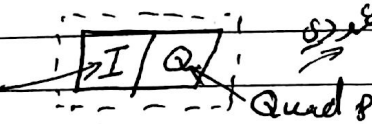
3- The Bandwidth of the modulated wave

4- The highest frequency to be reached after modulation.

5- sketch the wave form of the output directly below the carrier wave

Solution:

4 levels is done by taking two bits instate of one by eserial to parallel Converter.



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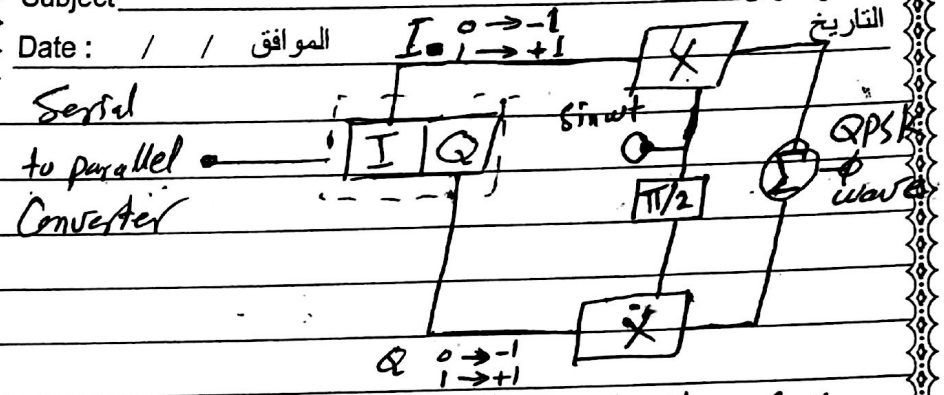

I Q determine the polarity of the wave.

Truth Table:

I	Q	QPSK wave	phase
0	0	$-\sin\omega t - \cos\omega t$	-135°
0	1	$-\sin\omega t + \cos\omega t$	$+135^\circ$
1	0	$\sin\omega t - \cos\omega t$	-45°
1	1	$\sin\omega t + \cos\omega t$	$+45^\circ$

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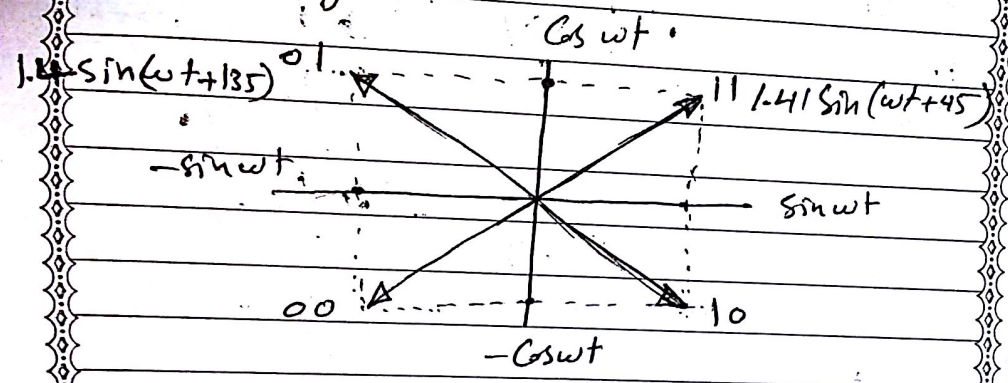
phase diagram :



distance between two phase = $\frac{360}{4}$

$= 90^\circ$

Find the wave of QPSK if I=0, Q=1

** $u = -\sin\omega t + \cos\omega t$

$= A\sin(\omega t + \phi)$

any two sinusoidal will give sinusoidal

* $u = A\cos\phi \sin\omega t + A\cos\omega t \sin\phi$

for any t (**u) & (*u) are equals.

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$I = A\cos\phi$

$I = A\sin\phi$

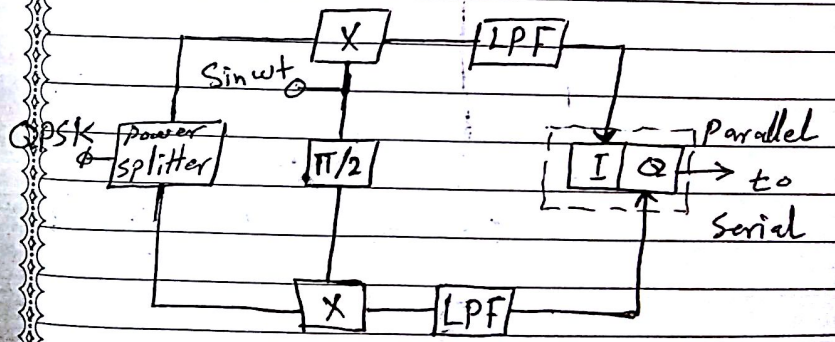
توسيع الدائرة وتحل

$A = \sqrt{2} = 1.41$

$\tan\phi = -1$ $\phi = 135$

$u = 1.41\sin(\omega t + 135)$

Detector :



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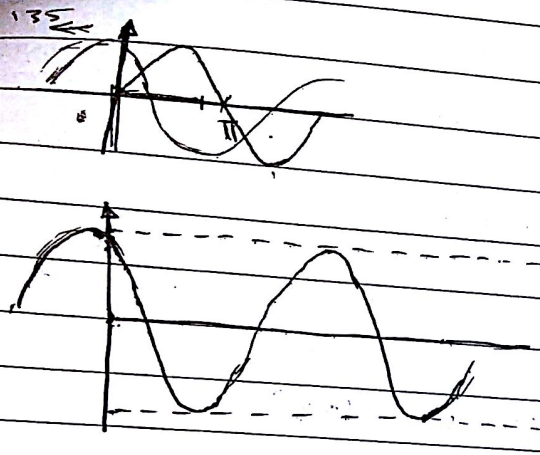
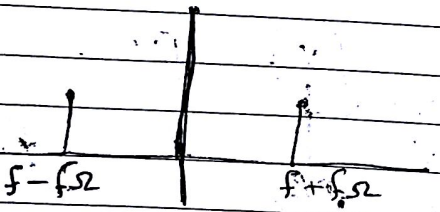
0 1 +135



spectrum :-



$f\Omega = \frac{R_b}{4}$ $BW = \frac{R_b}{2} = R_B$

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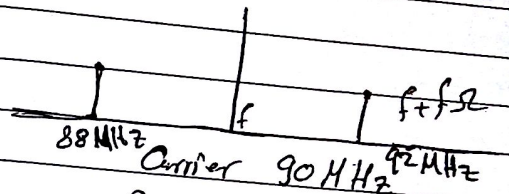

R_b = 8 Mbit/sec

$f\Omega = \frac{R_b}{4} = \underline{2\,MHz}$

Maximum frequency = 92 MHz

Minimum Frequency = 88 MHz

BW = 4 MHz